Day and Night Energy Harvesting

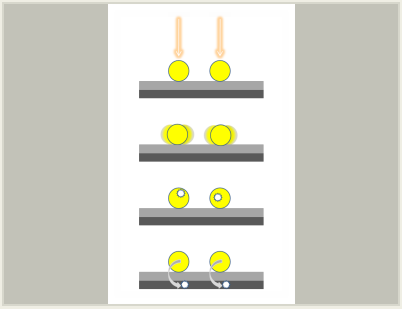
Completed Technology Project (2012 - 2012)

Project Introduction

Earth is a continuous source of blackbody IR radiation, peaking at a wavelength of 10µm.Over 24 hours there is energy in this emission comparable to visible solar radiation, but traditional photovoltaics are unable to harvest this wavelength range.This innovative technology, plasmonic nano-antennas, will be capable of harvesting IR radiation and producing DC electrical output.A MIM(metal-insulator-metal) diode structure is used to rectify electrons emitted from optically-energized nanoparticles Traditional photovoltaics are limited in two major ways: by the availability of light and the wavelengths that can be absorbed. Nighttime, seasons, and latitude limit the amount of radiation to absorb, and the available bandgap of materials for photovoltaic cells limits absorption to "shortwave" radiation (near-IR wavelengths and shorter). However, the Earth absorbs incident sunlight and re-emits the energy as "longwave" blackbody radiation, peaking in the 10 µm wavelength range, known as "earthglow" (as opposed to "earthshine", the visible light directly reflected by the Earth). Earthglow continues during nighttime, varying only about 25% during a 24-hour period. It is difficult to harvest with traditional photovoltaics, but not alternative radiant energy harvesting methods. An approach employing plasmonically-active nano-antennas offers a potential solution due to the tuneability of the resonant wavelength via antenna geometry. The ultimate goal of this project is to produce nano-antennas able to rectify infrared optical energy (terahertz frequencies), such as earthglow, into DC electrical current. The concept of nano-antennas has been around for many years, but due to fabrication difficulties, researchers have only recently begun to actually demonstrate them in the lab. Theoretically, single-junction photovoltaics have a light-to-electricity conversion efficiency limit of around 30%. Nano-antennas have a theoretical capture efficiency (incident light absorbed) of up to 95%, with lab demonstrations reaching 80%. The challenge facing researchers is converting this potential abundance of captured light efficiently into electricity, but nano-antennas promise a greater upper limit to energy production than present technology. Work on the energy harvesting project places NASA on the cutting edge of nano-antenna development. The design begins with an insulating substrate that is covered by a bottom electrode of metal film.

Anticipated Benefits

Constant drain applications would benefit, such as auxiliary systems, battery charge maintenance, and eventually primary power systems.



Project Image Day and Night Energy Harvesting

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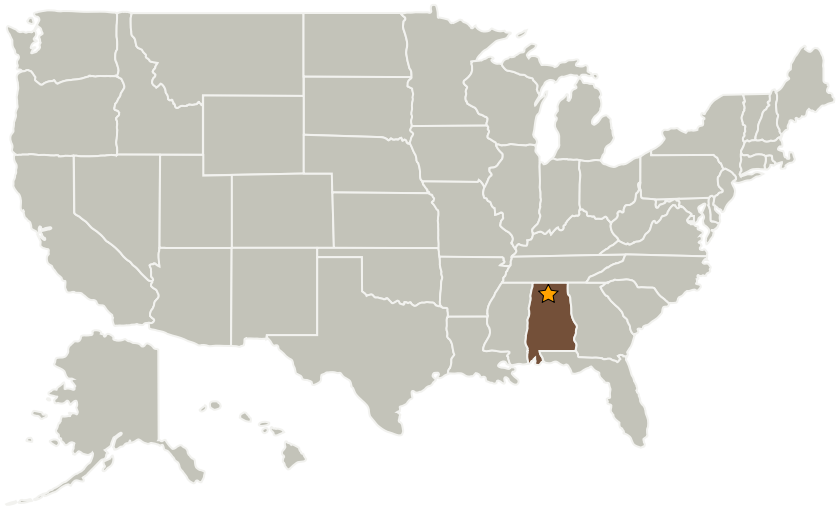
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
Miltec	Supporting Organization	Industry	

Primary U.S. Work Locations
Alabama

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Center Innovation Fund: MSFC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

John W Dankanich

Project Manager:

Angela D Shields

Principal Investigator:

Angela D Shields

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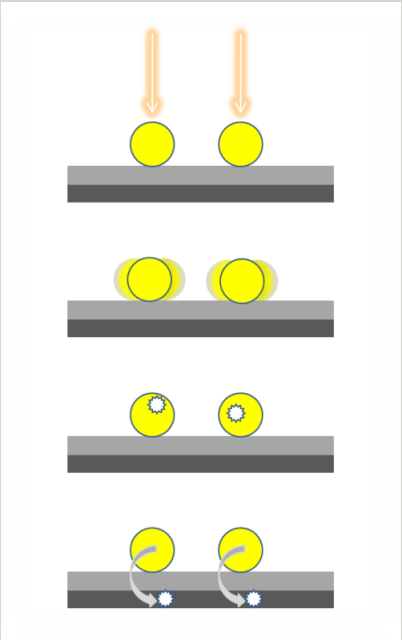
Images



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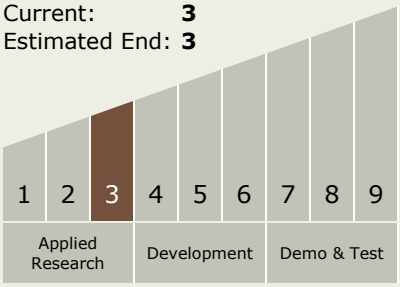
Project Image Day and Night Energy Harvesting
(https://techport.nasa.gov/image/1338)

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes